REMARKS

Claims 1-11 are pending in this application. By this Amendment, claims 1, 3 and 4 are amended and new claims 9-11 are added. Claims 1, 3 and 4 are amended to overcome claim rejections under 35 U.S.C. §112. Claim 1 has also been amended to address the teachings of the cited reference.

No new matter is added by this Amendment. Support for the language added to claims 1, 3 and 4 can be found in the claims as originally filed and in the specification at, for example, page 6, line 21 to page 7, line 7, page 14, lines 6-18, page 18, lines 1-18 and in Table 1 on page 17 of the specification. New claims 9-11 find support at page 7, lines 10-14, page 13, lines 8-11 and page 17, line 11 to page 18, line 5.

Applicants appreciate the courtesies shown to Applicants' representative by Examiners Jefferson and Estrada in the July 10, 2007 personal interview. Applicants' separate record of the substance of the interview is incorporated into the following remarks.

Reconsideration of the application is respectfully requested.

I. Rejection Under 35 U.S.C. §112

Claims 1-8 were rejected under 35 U.S.C. §112, second paragraph, as allegedly being indefinite and as allegedly being incomplete for omitting essential steps. This rejection is respectfully traversed.

With respect to the Examiner's allegations as being unsure as to exactly what Applicants are trying to claim, the remarks submitted by Applicants on December 21, 2006 illustrate that claim 1 requires a separation surface of the bonded silicon single crystal film with a roughness of 4.5 nm or less.

First, Applicants strenuously disagree with the allegations by the Patent Office that the term "smaller" as recited in claim 1 is an indefinite term.

The term "smaller" as used in claim 1 is not a relative term as alleged by the Patent Office. Instead, the term "smaller" is a comparative term which describes a relationship between a depth of formation of the separatory ion implanted layer and the dose of ion implantation, the dose changing based on the depth of formation of the separatory ion implanted layer. In other words, the term "smaller" is utilized to express a relationship between the dose of the ion implantation and the depth of formation of the separatory ion implanted layer.

As set forth on page 6, line 22 to page 7, line 1 of the present application, Applicants found that the less the depth of formation of the separatory ion implanted layer, the smaller the critical dose of the ion implantation necessary for the separation. The term "smaller" is not a relative term in the context of claim 1 because it does not refer solely to size (e.g., "small") and instead refers to a comparison as above that can readily be understood and clearly determined (i.e., is A larger or smaller than B?). Thus, the use of the term "smaller" in claim 1 is not indefinite as alleged by the Patent Office.

Nevertheless, Applicants herein revise claim 1 to recite that a dose of the ion implantation is lowered as the depth of formation of the separatory ion implanted layer measured from the ion implantation surface becomes less. Such eliminates use of "smaller" while similarly clearly stating the relationship. Claim 1 is thus clear and definite for this additional reason.

With respect to claims 3 and 4 allegedly including a relative term that renders the claims indefinite, claims 3 and 4 were amended to remove the word "smaller" from the claims. Claims 3 and 4 have further been amended to express the intended relationships more fully.

With respect to claims 1-8 as allegedly being incomplete for omitting essential steps, claim 1 is amended to incorporate adjusting a depth of formation of the separatory ion

implanted layer measured from the ion implantation surface and a thickness of the bonded silicon single crystal film through control of a magnitude of an ion implantation energy and setting the magnitude of the ion implantation energy.

Thus, Applicants respectfully request withdrawal of the rejections under 35 U.S.C. §112, second paragraph.

II. Rejection under 35 U.S.C. §103(a)

Claims 1-8 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 6,191,007 to Matsui et al. This rejection is respectfully traversed.

Although the Office Action initially indicates that claims 1-8 are rejected as allegedly being unpatentable over Matsui et al. The Office Action goes on to only discuss claims 1-8 and Yokokawa et al. Thus, Applicants assume that "Matsui et al." is a clerical error and that claims 1-8 are rejected as allegedly being unpatentable over U.S. Patent Application Publication No. 2001/0046746 to Yokokawa et al.

A. Planarization Step

The Patent Office alleges that paragraph [0009] of Yokokawa et al. teaches a planarization step of planarizing having the separation surface side of the bonded silicon single crystal film so as to produce the SOI layer. Instead, paragraph [0009] of Yokokawa et al. discloses that after a thick SOI wafer, including a wafer with an oxide film and a bare wafer, is produced, the wafers are grinded and polished. Additionally, the wafers are mirror polished to remove hazes therefrom and are exposed to a vapor phase etching treatment called PACE (Plasma Assisted Chemical Etching). Yokokawa et al. fails to teach that the separation surface side of the bonded silicon single crystal film is planarized to produce the SOI layer as recited in claim 1.

None of the grinding, polishing, mirror polishing or vapor phase etching of the wafers taught in Yokokawa et al. is the same as or similar to the recited planarization step of

planarizing the separation surface side of the bonded silicon single crystal film so as to produce the SOI layer required in claim 1. Moreover, nowhere does Yokokawa et al. teach or suggest that a separation surface side of the bonded silicon single crystal film as taught by Yokokawa et al. is exposed to a treatment or process that is the same as or similar to the planarization step required in claim 1. Thus, contrary to the allegations of the Patent Office, Yokokawa et al. fails to disclose the planarization step recited in claim 1.

B. Separation Step Surface Roughness

The Patent Office also alleges that paragraph [0067] of Yokokawa et al. discloses the separation step forming a separation surface of the bonded silicon single crystal film with a roughness (Rms) of 4.5 nm or less. On the contrary, paragraph [0067] teaches thickness distribution of the SOI layer after epitaxial growth or an epitaxial layer surface formed on the separation surface, and discloses that the epitaxial layer surface has a surface roughness or Rms value of about 0.29 nm. The surface roughness of the surface layer of the SOI layer, however, is actually discussed in paragraph [0066] of Yokokawa et al. and is identified as having a Rms value of about 7.6 nm.

The surface roughness of 0.29 nm for epitaxial layer surface as taught in Yokokawa et al. is not the same as or similar to the roughness of 4.5 nm or less for the separation surface of the bonded silicon single crystal recited in claim 1. Additionally, the surface roughness of 7.6 nm for the surface layer of Yokokawa et al. is greater than the upper roughness limit of 4.5 nm as required in claim 1. Thus, Yokokawa et al. fails to disclose the recited separation step forming a separation surface of the bonded silicon single crystal film with a roughness (Rms) of 4.5 nm or less recited in claim 1.

C. Dose of Ion Implantation

Nowhere does Yokokawa et al. teach or suggest a dose of the ion implantation that is lowered as the depth of formation of the separatory ion implanted layer measured from the

ion implantation surface becomes less, the dose of the ion implantation being such that the separation surface of the bonded silicon single crystal film formed in the separation step has the roughness (Rms) of 4.5 nm or less as recited in amended claim 1.

Contrary to the allegations of the Patent Office, Applicants submit that unexpected results were obtained and disclosed in the specification. Applicants found that the smaller the depth of formation of the separatory ion implanted layer becomes to achieve a desired thickness of the SOI layer, the smaller the critical dose of the ion implantation necessary for the separation becomes and that roughness of the separation surface is also related to the ion implantation dose such that a smaller dose of the ion implantation results in a smaller roughness of the separation surface (see page 6, line 22 to page 7, line 1 of the present application). Additionally, Applicants found that a smaller dose of the ion implantation can reduce the roughness of the separation surface, and can improve uniformity in the thickness of the SOI layer even when it is formed to a smaller thickness (see page 7, lines 4-6 of the present application).

The results summarized in FIGS. 6 and 7 of the present application confirm that the critical dose of ion implantation decreases substantially linearly with a decrease in the ion implantation energy which controls or adjusts based on the depth of formation of the separatory ion implanted layer to achieve the desired thickness of the SOI layer. The specification further describes that:

> FIG. 6 shows results of measurement of critical dose necessary for the separation when the separatory ion implanted layer is formed by hydrogen ion implantation, measured under varied hydrogen ion implantation energy (acceleration voltage). It is apparent that the critical dose decreases with decrease in the energy. More specifically, the critical dose decreases substantially linearly with decrease in the energy (an experimental formula expressing relation between the critical dose and energy obtained by linear regression also given in the drawing). FIG. 7 shows relations between hydrogen ion implantation energy (acceleration voltage) and separation thickness of the bonded silicon single crystal film 15 (or, depth of formation d1 of the separatory ion implanted layer 4) for the cases where the silicon

> oxide film 2 is formed on the bond wafer 1 side to a thickness of 30 nm and 145 nm, respectively. It is found for both cases that a higher energy results in a larger thickness of the bonded silicon single crystal film 15. It is also found that the same separation thickness can be obtained at a lower energy by reducing the thickness of the silicon oxide film 2.

The results obtained and disclosed by Applicants clearly set forth that the dose of ion implantation is lowered as the depth or the thickness of formation of the separatory ion implanted layer becomes less to achieve a desired thickness of the SOI layer. Further, the results obtained and disclosed by the Applicants set forth that the depth or thickness of formation of the separatory ion implanted layer is adjusted or controlled by ion implantation energy to achieve the desired thickness of the SOI layer.

This correlation and/or relationship between the dose of ion implantation, the depth or thickness of formation of the separatory ion implanted layer, the ion implantation energy and the desired thickness of the SOI layer is not taught or suggested by Yokokawa et al. Further, Yokokawa et al. fails to teach or suggest the unexpected surface roughness result of the separation surface as a result of the process. Accordingly, the results obtained by Applicants are unexpected and unobvious in view of the teachings of Yokokawa et al.

D. Conclusion

Applicants submit that claim 1 is not prima facie obvious, as alleged by the Patent Office, because Applicants have disclosed that the recited process limitations are required for a particular unobvious purpose and produce an unexpected result. Moreover, Yokokawa et al. fails to teach or suggest a method having the recited separation and planarization steps as required in claim 1. Nor does Yokokawa et al. teach or suggest a dose of the ion implantation that is lowered as the depth of formation of the separatory ion implanted layer measured from the ion implantation surface becomes less, the dose of the ion implantation being such that the separation surface of the bonded silicon single crystal film formed in the separation step has the roughness (Rms) of 4.5 nm or less as required by claim 1. Therefore, Applicants assert

that the teachings of Yokokawa et al. would not have led one of ordinary skill in the art to the present claims.

Because Yokokawa et al. fails to teach or suggest each and every feature of independent claim 1, claims 1-8 are patentably distinct over the references. Accordingly, reconsideration and withdrawal of the rejection of the claims under 35 U.S.C. §103(a) are respectfully requested.

III. New Claims

Yokokawa et al. further fails to disclose that a planarization step further comprises polishing the separation surface of the bonded silicon single crystal, wherein the SOI layer has a layer thickness uniformity of 1.5 nm or less following polishing (claim 9), or that a dose of the ion implantation is from $3 \times 10^{16}/cm^2$ to $5 \times 10^{16}/cm^2$ (claim 10).

Moreover, Yokokawa et al. fails to disclose that the roughness (Rms) of 4.5 nm or less for the separation surface of the bonded silicon single crystal film is obtained at the separation of the bonded silicon single crystal film from the second substrate as required in claim 11.

IV. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1-11 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

William P. Berridge
Registration No. 30,024

Brian C. Anscomb
Registration No. 48,641

WPB:BCA/hs

Date: July 23, 2007

OLIFF & BERRIDGE, PLC
P.O. Box 19928
Alexandria, Virginia 22320
Telephone: (703) 836-6400

DEPOSIT ACCOUNT USE AUTHORIZATION
Please grant any extension necessary for entry;
Charge any fee due to our Deposit Account No. 15-0461